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REVISION

ABSTRACT

This report was prepared by staff members of the Interagency Ecological Program (IEP) and describes a proposed baseline monitoring program for the San Francisco Bay-Delta Estuary (Estuary). This program modifies and is proposed to replace the existing D-1485 monitoring program conducted by USBR and DWR as part of their water rights permits and includes physical, chemical, and biological components (including zooplankton and benthos).

(updated map not ready yet)

INTRODUCTION

The IEP was formed in 1970 when the U.S. Bureau of Reclamation (USBR), the Department of Water Resources (DWR), the U.S. Fish and Wildlife Service (USFWS), and the California Department of Fish and Game (DFG) signed a Memorandum of Understanding (MOU) to coordinate environmental studies in the Delta and Suisun Bay. Prior to the signing of the MOU in 1970, these four agencies were conducting various estuarine environmental studies associated with the Federal and State Water Projects and agency programs. In 1969-70, the State Water Resources Control Board (SWRCB) held major hearings and established new water quality requirements for the San Francisco Bay-Delta Estuary which resulted in the issuance of Water right decision 1379 (D-1379) in 1971. A condition of this water right permit required USBR and DWR to conduct a compliance monitoring program.

This compliance monitoring program has been periodically revised via the SWRCB hearing process, with the last major revision occurring in 1978 (D-1485) and resulted in the addition of fishery monitoring studies in San Francisco Bay (downstream of the Entrapment Zone).

Although the physical/chemical and phytoplankton elements of the monitoring program were not officially part of the IEP until 1991, the two programs were closely coordinated and provided the primary source of data for the interagency studies.

The interagency MOU was modified in 1985 to include the U.S. Geological Survey (USGS) and the SWRCB. The field efforts were also expanded in 1985, to include hydrodynamic studies in San Francisco and San Pablo Bays. Membership in the IEP was again expanded in 1990 to include the U.S. Army Corps of Engineers (COE), San Francisco District Office and again in 1992 to include the Environmental Protection Agency (EPA), Region 9.

The IEP is the largest, longest-term, and most comprehensive environmental program in the San Francisco Bay-Delta Estuary.The primary goal of the IEP is to determine the impact(s) of Federal and State water project operations on the estuary through routine monitoring and applied special investigations and to recommend modifications to management that will minimize or eliminate these impacts. However, in reality, these investigations entail at least some consideration of both project and non-project factors. Further details on the organization, management, specific program elements, objectives, study plans, and examples of data collected are available in IEP annual reports.

IEP has recently been reviewing its programs with the intent of making them more responsive to management of the Estuary. IEP coordinators authorized a review of the entire IEP organization culminating in the report "A Review of the Interagency Ecological Study Program and Recommendations for its Revision, August 1993". The report also recommended a review of the existing D-1485 compliance monitoring program and called for the merger of the present water quality and zooplankton monitoring programs and

closer coordination with the fishery element in order to improve efficiency and provide more meaningful data.

In order to accomplish the review of the monitoring program, an ad hoc committee was established consisting of representatives from USBR, DWR and DFG and assisted by Drs. Wim Kimmerer, Tim Hollibaugh and Jerry Turner, consultants to IEP. The committee also met and exchanged information with staff from the Aquatic Habitat Institute, San Francisco Estuary Project Monitoring Committee, SWRCB, and Regional Water Quality Control Board's (RWQCB) 2 and 5.

The initial committee meetings were devoted to conceptual discussions on monitoring program objectives, and the various approaches the committee might take in developing a revised monitoring program. The group also re-evaluated the existing D-1485 monitoring program and reviewed other programs being conducted in the San Francisco Bay-Delta Estuary. The following assumptions and concepts emerged from committee discussions and guided development of the baseline program:

1. The committee would develop the proposed baseline monitoring program in a systematic and comprehensive manner, using existing data and knowledge whenever possible to support recommendations.
2. The committee would initially design a monitoring program as if no monitoring programs were presently in place. Then after a scientifically sound baseline monitoring program had been designed, and reviewed, it would be coordinated with existing monitoring programs

to maintain continuity of long-term monitoring in key locations.

3. Primary objectives of the baseline monitoring program should include:

   a.) assurance that compliance with water quality standards established by the SWRCB can be readily determined.

   b.) assurance that impacts on beneficial uses by State and Federal Water Project operations can be determined so operational modifications can be evaluated and threats to contractual water quality objectives identified.

   c.) provision for some continuation of long term monitoring of trends or changes in water quality patterns to determine if the objectives in the Sacramento-San Joaquin Delta (Delta W.Q. Control Plan) to protect beneficial uses of water are adequate.

4. Constituents selected to be monitored in the proposed baseline program would be those for which there was a historical precedent.

5. Where possible, permanent, multi-parameter water quality in-situ monitoring sites should be used to minimize the need for an extended "grab" sampling program.

During the course of their evaluation the committee progressed through a number of steps to develop, support and

document recommended baseline and special studies monitoring program changes. It was apparent that steps based on the experience and working knowledge of the committee members needed to be organized and applied in a systematic and comprehensive manner and reference was frequently made to a paper authored by Dr. Brook Bernstein, "An Integrated Assessment Framework --" (1990). (A Complete description of committee review procedures is presented in Appendix I.)

REVISED MONITORING PROGRAM FOR SACRAMENTO-SAN JOAQUIN DELTA ESTUARY

The concept guiding the development of this proposed modified plan was to retain an adequate base-line surveillance effort, but streamline the existing program so that committed resources could be re-directed. This streamlining would include combining the current physical/chemical, phytoplankton, and zooplankton activities to minimize redundancy and incorporate synoptic sampling and integrating a more relevant benthos element. The routine base-line program would be sufficient to sustain long-term trends analyses and ensure a continuing historical record of changing conditions. Resources that became available through this consolidation could be utilized to support specific projects designed to address problem areas defined in the revised IEP plan. It was further envisioned that a substantial contribution to the routine long-term data base could be provided by upgrading and expanding the continuous recording, multi-parameter network. This system would be provided with telemetry capabilities so critical "indicator" parameters could be monitored on a real time basis. This continuous source of information would be supplemented by a reduced, but strategically located network of discrete sampling sites.

<u>Baseline Surveillance</u>

a) Physical-chemical; consolidation of the existing D-1485 discrete monitoring locations was considered an initial step in streamlining the current compliance program. The upper

estuary monitoring zone was portioned into regions, each representing a geographical area with similar water quality characteristics. Hierarchial cluster analyses were used to group historic discrete sampling sites that behaved in a similar fashion over time relative to their physical, chemical, and biological characteristics. This resulted in a series of cluster diagrams describing these associations relative to year, type and seasonal variation. After establishing these site groupings discrete locations were chosen to represent a geographical region(s). Sites designated for "physical-chemical" sampling are shown in Table I.

The list of physical-chemical parameters mandated by D-1485 was also reviewed. The historic trends they were presenting and their relative importance in identifying significant water quality patterns were evaluated by reviewing historic spatial and temporal plots of each parameter. The committee determined many of the parameters were originally included to provide a background in characterizing the estuary and, having accomplished that objective, they felt there was no longer a need for their collection. Some parameters depicted trends that were either predictable, closely correlated with more significant parameters or displayed relative stability over their period of record and continuation in the program would provide minimal returns. Several of the physical parameters including air temperature,

wind patterns and solar radiation intensity were incorporated into the multi-parameter network to be continuously monitored. Final recommendations are shown in Table II.

TABLE I

Inter-agency#	Latitude	Longitude	Physical Chemical	Multi-param.	Zoo-plkton	Benthos	Phyto-plkton
C3	38°20'45"	121°32'42"	*	*			*
C7	37°47'11"	121°32'22"		*			
C9	37°49'50"	121°33'09"				*	*
C10	37°40'34"	121°15'51"	*				*
D4	38°03'45"	121°49'10"	*		*	*	*
D6	38°02'40"	122°07'00"	*	*	*	*	*
D7	38°07'02"	122°02'19"	*		*	*	*
D8	38°03'36"	121°59'20"	*		*		*
D10	38°02'47"	121°55'02"		*	*		
D12	38°01'04"	121°48'06"		*	*		
D16	38°05'50"	121°40'05"			*	*	
D22	38°05'40"	121°44'17"			*		
D24	38°09'27"	121°41'01"		*		*	
D26	38°04'40"	121°34'00"	*		*		*
D28	37°58'14"	121°34'19"	*	*	*	*	*
D41	38°01'50"	122°22'15"	*			*	*
D41A	38°05'20"	122°26'20"				*	
P8	37°58'42"	121°22'55"	*	*	*	*	*
MD10	38°02'42"	121°25'04"	*		*		*
S42	38°10'50"	122°02'45"			*		
DFG 80					*		
DFG 32					*		
E.Z. 1	Changes w/	Entrapment	*		*		*
E.Z. 2	Zone	Location			*		

TABLE II

List of Parameters and Sampling Frequencies

Parameter	Discrete sites (monthly sampling)	Multi-parameter sites (continuous)	On-board recording (vert./horiz. profiles)
Nutrient series (inorganic/organic N-P	*		
Secchi	*		
Phytoplankton	*		
Chlorophyll a (extracted)** and (in-vivo fluorescence)*	* *	*	*
Water temperature	*	*	*
D.O.	*	*	*
E.C.	*	*	*
Turbidity	*	*	*
Wind speed/direction		*	
Solar radiation		*	
Air temperature		*	
Water column depth	*		
Zooplankton	*		
Benthos	*		

Monitoring frequencies for these base parameters were also statistically examined to determine the minimum sampling intervals necessary to still reflect long term variations in the water quality trends. Historic parameter trends were compared at different time scales using coefficients of variation and daily means. This resulted in a series of histograms showing the variance of individual variables over given time increments. Time increments were selected that would not jeopardize the ability to detect significant variations in long term water quality trends (Table II).

A complete accounting of the statistical procedures used in the above evaluations is presented in Appendix II. Supplementing the data collected at the proposed discrete sites will be horizontal and vertical profiles of the water column taken during each sampling run (Table II). A submersible sensor package will be lowered for the vertical profiles and the information utilized to study stratification patterns and surface vs bottom phenomena. A through-hull pump intake will continuously supply water to a flow-through manifold of sensors while the vessel is underway between discrete monitoring sites.

b) Benthos; an integral part of the proposed baseline monitoring program is a benthic monitoring element with the following objectives:

- To monitor trends in the abundance and distribution of benthic fauna.
- To detect major changes in species composition (especially exotic introductions).

- Determine if changes are related to Project operations.
- To provide information that is compatible with other elements of the baseline program

These objectives served as a basis for revision of the existing benthic monitoring program. Benthic data collected between 1980 and 1990 were analyzed to provide answers to three questions that are key to the design and implementation of a new benthic monitoring program:

1) What should the sampling frequency be?
2) What should the sample replication be?
3) What should the spatial distribution of sites be?

Results from analyses were used to develop a revised monitoring scheme. Results are summarized below, but a more detailed explanation of the supporting analyses is present in Appendix III.

(sampling frequency)

Coefficients of variation and power of detection curves were used to answer this question. Variance calculations show the benthic community is highly variable both temporally and spatially. Power of detection curves showed that benthic samples must be collected at least monthly to quantify the annual variation in individual species and community abundance.

(sample replication)

Variance calculations and power of detection curves show the current benthic monitoring program is collecting the minimum number of sample replicates (3 per site). The number of replicates should be increased to reduce within site variability.

(spatial distribution)

To increase the potential for meeting the stated objectives, sites should be chosen where the maximum chance of collecting a species occurs. In this way, the most information will be obtained for the least amount of effort. However, because of the high variability in species abundance among sites, a sufficient number of sites must be sampled to allow reasonable confident documentation of species distributed trends. Ideally, one or more sites should be sampled in each environmentally distinct region within the Delta and Suisun Bay.

Results of regional based analyses show maximum species information is obtained at three of the eight sites currently sampled. That is, given the current level of effort the best chance of finding a species within each region occurs at Sites D7C, D4L, and D28AL. These results are limited by the relatively few sites sampled in each region, or in many cases the complete lack of sites within a region. Thus, some modifications in regional coverage is needed to adequately determine distribution changes in the benthos of the upper estuary.

In summary, the analyses show there is substantial spatial and temporal variation in the benthos of the upper estuary. Thus, a major increase in sampling effort is

required to significantly change the analytical sensitivity. Monthly sampling, however, is the optimal frequency to meet the stated objectives and additional sample collections would not significantly enhance results. Results suggest the existing site distribution overemphasizes sampling in certain parts of the Delta so there is a need to establish new sites in different regions.

Given the stated objectives and results from the various analyses, a benthic monitoring program with the following attributes is recommended: (Please refer to the Water Quality Surveillance Program-Volume III Annual compliance report by DWR for field and laboratory procedures used in the current benthic monitoring program).

* Benthic and sediment sampling will continue at three existing sites: D7C, D4L, and D28AL. Sampling at the other five existing sites (D11C, D4R, D4C, D19C, and D28AR) will be discontinued. Instead, seven new sampling sites will be established (Table III). Sampling these sites will provide better spatial coverage of the monitoring area and should permit a better understanding of SWP and CVP related impacts.
* The number of replicate samples will be increased from 3 to 4 per site to reduce within site variability in abundance estimates. All other sample collection methods will remain the same.
* Species biomass will be estimated bimonthly at all sites by measuring total wet weight. Existing curves relating tissue weight to total weight will be used for organisms, such as clams, with a substantial portion of their total weight arising from nonliving parts. All

other sample analysis methods will remain the same. Routine measurements of both biomass and abundance would permit estimates of benthic production. Additionally, biomass estimates provide information useful to understanding benthic trophic dynamics. Total sites designated for benthic monitoring are shown in Table I.

c) Zooplankton; the current monitoring program (see description in Appendix IV) has been fruitful in determining species composition, population, size and distribution, and long-term trends in abundance, but it has not been very effective at determining the factors that control zooplankton population size. A knowledge of the mechanisms that affect abundance would enable the prediction of population size under a spectrum of possible future environmental conditions. Such knowledge is essential for the proper management of the estuary. Hence, in recent years a consensus has developed that the monitoring program should be reduced in order to reallocate time and effort to cause and effect studies that would provide an understanding of the mechanisms that regulate zooplankton abundance. These proposed cause/effect studies will be developed within the new revised IEP format.

The committee realized that since the Department of Water Resources currently conducts a monitoring program for a variety of water quality parameters, cost reductions and greater efficiency could be achieved if the field sampling efforts of these two programs were combined. The IEP committee developed recommendations on station and parameter changes for the tow programs and to coordinate the field work.

Ideally, we should also combine the concomitant monitoring of the larval bass and zooplankton studies, but this is dependant on whether or not similar results can be obtained due to different methods of sampling in relation to the tide. Even if the studies could be combined it would still be necessary to sample separately for Neomysis.

To determine whether or not a reduced monitoring program would indeed provide the same statistical results as the current monitoring program, a set of 6 analyses were performed on each of 17 major taxonomic units enumerated by the project during March through November from 1972 through 1988. (Oithonids were taken too infrequently to be analyzed by this method.)

Each analysis removed the effects of season and specific conductance from the population densities. These modified population densities, or anomalies, were regressed against year to compare trends (the slope of the densities). The anomalies of those taxonomic units with regressions which had insignificant F values for both the historic sampling program and the reduced sampling program were analyzed using a Wald-Wolfowitz Runs test to determine if there was a tendency for positive anomaly values to be followed by positive anomaly values and negative anomaly values to be followed by negative anomaly values. The patterns of the runs were also compared to see whether or not positive and negative anomaly values occurred in the same years.

The resulting network of stations was deemed adequate to measure long term trends in abundance and composition. Stations designated for zooplankton sampling are shown in Table I. See Appendix IV for a completed description of the analysis.

d) Phytoplankton;

Although chlorophyll a analyses and measurements of in-vivo chlorophyll fluorescence will serve as a convenient indicator of phytoplankton activity, it will still be necessary to monitor distribution and composition of the phyto community. Primary productivity is the initial step in the estuarine food chain and changes in dominant species could be indicative of major changes in water quality or other environmental factors in the estuary. Observations of phytoplankton trends could potentially explain developing trends in the higher trophic levels.

Since continuous, real-time fluorescence values will be available from the expanded multi-parameter network, discrete sampling for enumeration and identification of actual organisms was modified so it could be integrated into the proposed baseline surveillance program. When real-time observations from any given region indicate an anomaly or set of conditions requiring more detailed information, an immediate and specific field investigation could be initiated. A statistical approach, similar to the one described in the physical-chemical section was used to design a schedule that was compatible with the remaining program and still provide adequate information for detecting short-term changes and documenting long-term trends.

Phytoplankton species composition data utilized for these analyses were taken from 15 sampling sites throughout the current study area. Since the number of data points available were too large for a comprehensible analysis, the data matrix was reduced to a manageable size as follows: First, the data were divided into two seasons, spring-summer (March-July) and fall (August-October), which were analyzed separately. The seasonal periods were determined from observed changes in chlorophyll a and cell

density maxima among sites and years. Second, since the focus of this study was on long-term, interannual changes in phytoplankton communities, data for each site were averaged over the entire season for each year. Third, the sites were grouped into geographical regions which had similar phytoplankton communities over time. Sites with similar communities were determined with hierarchial cluster analysis of site-year data. Sites which did not associate by geographical region or demonstrated inconsistent associations over time were classified as miscellaneous ungrouped sites. Data for all sites within a region were averaged for the analysis. Final site selections were integrated into the baseline surveillance network and are shown in Table I.

A more detailed explanation of the statistical methods utilized is referenced in Appendix II.

Continuous Monitoring Network

Modification of the baseline surveillance program requires greater reliance on remote, automated equipment to track conditions in the upper estuary. A strategically located network of continuous recorders interfaced with a real time telemetry system would provide the surveillance necessary to detect daily changes in the system and contribute significantly to maintaining a record of long term trends. This provides a more effective means of making information available for management decisions and reduces dependence on the bi-monthly grab sampling to characterize developing trends. The telemetered data would allow real-time compliance determinations for water quality standards, and improve the ability to respond rapidly to conditions requiring immediate action.

There are already three major recorder networks operating in the delta region. (see monitoring map for P,S and MP designations).

1.) a series of salinity and water stage recorders (P) providing daily, real-time data for operation of the state and federal water projects and for determining compliance with established water quality standards.

2.) a distribution of salinity and stage recorders throughout Suisun Marsh (S) collecting information to determine compliance with D-1485 standards and for operating Marsh facilities.

3.) a network of six automated, continuous, multi-parameter recorders (MP) providing data for water right compliance determinations, project operations, water quality surveillance, and flood management assessments. An extended list of water quality and hydrodynamic parameters continuously measured include specific conductance, dissolved oxygen, pH, water/air temp, wind speed/direction, solar radiation, tide elevation and, intermittently, chlorophyll fluorescence, optical back scatter and water velocity at select locations. Critical information from designated "indicator" parameters is telemetered hourly to the California Data Exchange Center in Sacramento.

Recognizing these systems already provide some surveillance level of conditions in the upper estuary, multiple comparison tests were conducted between data trends in each region designated in the statistical analyses for discrete monitoring in Appendix II and existing

multiparameter sites. This established the feasibility of a continuous recording, multi-parameter site adequately representing conditions (in lieu of existing discrete sites) within each designated region. Following this analysis, the IEP plan recommends:

1.) expanding the multi-parameter network by adding locations at:

   a.) Green's Ldg; this would serve as a "rim" site monitoring Sacramento River water prior to entering the Delta. The "rim" site for the San Joaquin River is already part of the existing network.

   b.) Old River opposite Rock Slough on Bacon Island; this site would monitor conditions in the central Delta and provide data on the quality of water being transferred across the Delta to the SWP.

   c.) at the juncture of Old River and Grant Line Canal; this site would provide a surveillance of conditions in the south Delta and monitor the quality of water being exported through the CVP facility at Tracy.

2.) continued upgrading of existing recorder sites by increasing the number of parameters and location of sensors (top/bottom), expanding real time capabilities (telemetry) and replacing obsolete techniques with state of the art technology.

3.) consolidate or relocate existing continuous monitoring locations to increase efficiency, eliminate redundant site installations and avoid maintaining duplicate data sets for the same location.

4.) coordinate proposals to establish recorder systems by operators outside IEP so a compatible, well integrated network can be maintained.

5.) create a centralized file of all continuous recorder data that is consistently updated and available in a convenient electronic format to all interested users.

All existing and proposed continuous recording, multi-parameter monitoring locations are shown in Table I.

QUALITY ASSURANCE AND QUALITY CONTROL PROCEDURES

Information provided by this monitoring proposal will be used to determine compliance with established water quality standards, guide management decisions for this estuary and measure progress in meeting planning goals. This adds another level of importance beyond the objectives of determining environmental needs for fish and wildlife and evaluating potential impacts by water project operations. Recognizing this critical need for high quality information mandates that the data collected be representative, compatible and scientifically defensible. This will be accomplished by establishing a comprehensive quality assurance/quality control program (QA/QC). Due to the broad scope of this monitoring proposal, the involvement of numerous federal and State agencies, and the need to coordinate with other existing and proposed monitoring activities there must be a common set of specifications for the accuracy and precision of the data collected and uniformity between procedures for collecting, analyzing and storing information. These requirements will be presented in a QA/QC project plan specific for the IEP proposal. The plan will follow a format similar to the one formalized by the Environmental Protection Agency in the Code of Federal Regulations. The format includes a document which presents an orderly assemblage of management policies, objectives, principles, and organizational responsibilities on how the entity intends to produce data of documented quality and provide for standardization of operation procedures. The IEP currently relies on the individual QA/QC procedures used by each member agency and although this has

proven to be an effective quality assurance procedure it is fragmentary and sometimes conflicting. The QA/QC plan associated with the IEP monitoring proposal will consolidate these isolated procedures into a specific comprehensive plan that addresses the full IEP study agenda.

DATA ANALYSIS AND REPORTING

The existing IEP monitoring program has generated a vast amount of data, most of which has not been subjected to a detailed analysis until recently. This is probably due to the underlying philosophy of the monitoring program, which was to evaluate the effects of project operation. In this respect, the monitoring data have been used to indicate that problems exist (e.g., species introductions, salinity intrusion, nuisance blooms), but monitoring objectives not related to project operations have received only marginal attention. This seems to be due to the fact there was no specific requirement for further analysis in the monitoring mandate.

We recommend that a specific data analysis element be included as an integral part of the proposed monitoring program, and standard procedures should be established to ensure it is carried out. This analysis should occur at different levels, depending on the specific monitoring objective.

1. Real-time examination of data for detection of problems, particularly applicable to continuously-monitored data such as dissolved oxygen, salinity, and chlorophyll measured at both the "fixed" multi-parameter locations and by on-board vertical and horizontal profiling. Although this is being done at present, the emphasis is on protection of water supplies and compliance with D-1485 standards.
2. As sampling results are received, scientific managers, as part of the quality control procedure, should immediately review each set of data after it has been entered and checked. The manager should at least

examine the data graphically to look for suspicious values, missing data, or other unexpected results. Entry into the IEP data system should occur as soon as the manager has inspected the data. A chain-of-custody procedure should be instituted in which the manager certifies that the data are ready to be used, then passes the data on to the manager of the data system. Copies of the data on disk and paper should be distributed with a cover letter indicating that the quality control procedure has been completed. Distribution should be from the central IEP facility to prevent different versions of the same data from being used.

3. In addition to mandated compliance documents, timely reporting and distribution of all data for peer review should be required.

The IEP data management committee has addressed these concepts and the following recommendations have been approved by the Agency coordinators.

a) The program-wide STORET storage and retrieval mandate is suspended. Individual agencies may choose, and are still encouraged, to continue to store and retrieve data from STORET. Program managers are also still required to perform the established QA/QC procedures developed by the Data Management Committee.

b) Individual program managers are allowed to disseminate data upon request, from their data base of choice.

This data transfer may take place only after the data has been made available to the central repository. This policy will remain in place until long-term recommendations are implemented.

c) A data repository will be established and used as a file server for standardized IEP data files in ASCII format.

The central data repository will be on line continuously and allow access, in read only mode, to interested parties who wish to download ASCII files for analysis. Each ASCII file, including all updates and correction, will be fully documented on line. This **would not** be considered the main data base, but only on line storage for the purpose of user access. The Data Management Committee will develop a list of technical requirements.

d) Program managers will provide ASCII data files, and pertinent updates to a technical information specialist who will manage the central repository. The data will be validated using established QA/QC procedures before they are provided to the TIS. The Data Management Committee will develop storage criteria and a schedule.

4. Annual data reports should be prepared as soon as possible after the end of the calendar year. These should include the data as an appendix, summary statistics describing the data, and a brief analysis of any trends or unusual patterns observed.

5. Periodic reviews should be made of all data collected by the monitoring program approximately every 5 years. These reviews should include: a complete graphical and statistical analysis of spatial and temporal trends over the last 5 years and the entire duration of the monitoring program; the application of statistical techniques necessary to resolve the various sources of variability (e.g., time series analysis, tidal filtering, principal component analysis); and a synthesis of the results of monitoring with those from special studies and from the literature. This synthesis should attempt to determine what changes have occurred, why they might have occurred, and what should be done to resolve questions.

6. Publication of results as either IEP technical reports or in peer-reviewed literature is encouraged in the IEP.

The peer review process is critical and the means by which scientific results become validated and accepted. Although peer review within the IEP can provide some of this validation, outside review is essential to maintain the quality of the work being done.

7. An evaluation of the monitoring procedures and sampling frequencies should occur after each of the 5-year reviews, with the data analysis from those reviews providing the basis for the evaluation. Periodic, critical reviews of the entire program or any of its elements should be encouraged to justify ongoing activities.

COORDINATION

The IEP represents the major Federal and State agencies that already have the resources, knowledge, and, in some cases, the regulatory or legislative mandate to conduct environmental studies in the San Francisco Bay-Delta Estuary. It was the goal of the IEP Committee staff to identify these resources and attempt to consolidate them into a more efficient and comprehensive monitoring effort. Ideally, all environmental studies in this estuary would be physically integrated, but since these programs cannot be conducted under a single directorship, close coordination between the IEP program and other related activities is essential for a well organized and united effort. An example of this coordination effort involves two non-IEP programs that are currently being reviewed by IEP planners to minimize redundancy and supplement our baseline surveillance monitoring:

1) San Francisco Estuary Regional Monitoring Program (RMP); this program provides information on contaminant concentrations (organic and trace element) in the San Francisco estuary and their possible ecological effects.

2) A Demonstration Project for a Long Term Program to Monitor Water Quality and Ecological Status of San Francisco Bay; this program will provide fundamental information about physical, chemical and biological properties and develop a protocol for synthesizing the data into an integrated statement of the ecological status of the estuary.

TABLE III

Name, location and rationale for five new benthic monitoring sites.

Site Name	Site Location	Rationale for Selection
D41A	Light 2, mouth of the Petaluma River, San Pablo Bay	Routine sampling should provide information relating benthos in San Pablo Bay to benthos in Suisun Bay.
D41	Ship channel off Pinole Pt.	Complements existing site in San Pablo Bay (D41A) sampled by USGS and DWR since 1988. This is also a discrete W.Q. site.
D6	Ship channel in Suisun Bay near Martinez	Provides better spatial coverage of Suisun Bay. Samples a habitat different from site D7 in the Grizzly Bay shoal area.
D24	Sacramento River below Rio Vista Bridge	Provide better characterization of lower Sacramento River area.
D16	San Joaquin River at Twitchell Island	Provides information on the benthos of the lower San Joaquin River.
P8	Stockton Ship Channel at Rough & Ready Island	Provides information on the benthos in unique habitat reflecting high BOD loadings.
C9	West Canal Opposite intake channel to Clifton Court Forebay	May permit better assessment of water project related impacts to the benthos.

PROVISION FOR SPECIAL STUDIES

Priority must be given to resolving the myriad of complex environmental issues confronting management. Addressing these issues will require specifically designed studies to answer specific questions and provide information necessary to make decisions that are both timely and constructive. Past efforts, although constrained due to the commitment required by the surveillance monitoring, have broadened our understanding of a highly dynamic system.

Following the basic concept of this plan, which is to consolidate efforts now dedicated to routine monitoring to free resources so they can be re-directed to specific problem areas, provision has been made for the development of a special studies agenda. This agenda of special study proposals would be submitted annually to the Board for their review and concurrence prior to implementation.

The IEP recognized this need in restructuring the interagency program and provided for a Special Studies component. Project work elements within this component would be developed to address high priority issues, extend our basic knowledge of the system, and evaluate measures proposed for the Estuary Monitoring component. Recommendations resulting from this process and project proposals endorsed by administrators of the Research Enhancement Program Manager would serve as the primary source for compiling the annual agenda.